Proposed Plan for Cleanup of Groundwater at the South Air Force Research Laboratory – Sites 37, 120, 133 (Operable Unit 4) and 321 (Operable Unit 9), Edwards Air Force Base

April 2006

The Air Force invites the public to comment on the proposed cleanup plan for contamination in groundwater beneath the South Air Force Research Laboratory (AFRL) at Edwards Air Force Base (AFB), California (Figure 1). The groundwater occurs in fractured granite (very hard crystalline rock with cracks in it). Neither the soil nor soil vapor contains contaminants that pose a risk to human health or the environment.

The AFRL, as an associate organization at Edwards AFB, conducts rocket testing and research east of Rogers Dry Lake. The base cleanup program calls the entire AFRL area Operable Units 4 and 9. The South AFRL roughly includes the southwestern quadrant of the AFRL, encompassing maintenance shops, civil engineering facilities, and administrative buildings.

This Proposed Plan identifies the Preferred Alternative for addressing the contaminated groundwater at the South AFRL. It also summarizes non-preferred alternatives that were evaluated. This Plan is being issued as

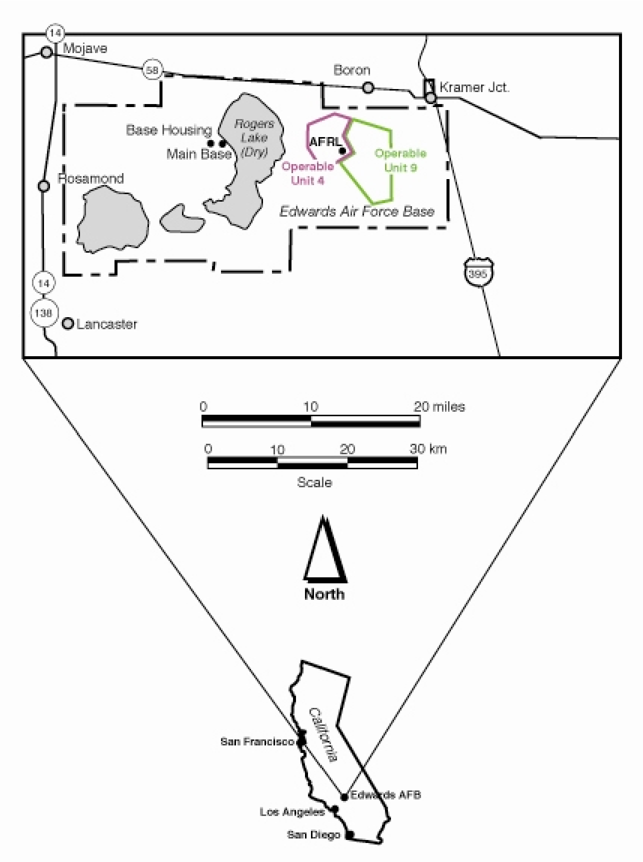


Figure 1 - Edwards Air Force Base

Share Your Opinions

Your input helps the Air Force choose the best way to deal with contamination at the South AFRL. You may fill out and mail a comment form, send an e-mail, or fax your comments to the Air Force. You can send your comments to Mr. Gary Hatch at the address, e-mail address, or fax number listed on page 23. The comment form is on page 25. Your comments must be postmarked by the last day in the comment period:

Public Comment Period: 7 April 2006 to 8 May 2006

You may also share your views by attending a public meeting. The Air Force is holding a public meeting on **25 April 2006** from **5:30 pm to 7:30 pm** at the **Boron Senior Citizen Center, 27177 Twenty Mule Team Road in Boron**. There will also be a meeting on **12 April 2006** for AFRL workers in the **Rocket Room (Building 8356)** from **11:00 am to 1:00 pm.**

During these public meetings you can meet the cleanup team, ask questions, and view maps of the project. The Air Force will give a presentation to explain their plan for cleaning up the contamination. They will also answer your questions and give you a chance to speak for the public record. Written comments will be accepted at the public meetings.

required by the public participation requirements in the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Section 117(a), as amended by Superfund Amendments and Reauthorization Act of 1986 (SARA) and the National Contingency Plan (NCP, the Superfund regulation) Section 40 CFR 300.430(f)(2) and (f)(3). The Plan summarizes information found in the Remedial Investigation Summary Report for Operable Unit 4, the Remedial Investigation Summary Report for Operable Unit 9, the Focused Feasibility Study for the South AFRL, and other documents found in the Administrative Record. These documents are available for review by anyone who is interested, at the locations listed on page 23.

The Air Force as the lead agency is working with other agencies to select a final cleanup plan for the South AFRL. The other agencies are the U.S. Environmental Protection Agency (U.S. EPA), the California Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board (CRWQCB), Lahontan Region. The Air Force will review the public comments submitted during the 30-day period, and will consult with the U.S. EPA and the California regulators to decide whether to accept the Preferred Alternative, modify it, or recommend a different Preferred Alternative. The Air Force and U.S. EPA will then jointly select the remedy for the South AFRL (in consultation with the state regulators).

Edwards AFB was listed on U.S. EPA's National Priorities List (NPL) on August 30, 1990 (the NPL is U.S. EPA's list of the nation's most contaminated sites). Shortly afterward, Edwards AFB entered into a Federal Facility Agreement (FFA) with U.S. EPA Region IX, the California DTSC, and the CRWQCB. The FFA provides the framework for involving federal and state regulators in developing and implementing cleanup decisions.

Site Background – Where the Contamination is and How it Got There

The South AFRL includes facilities that began operation in the 1950s and are still active today. The underground contamination at the South AFRL is primarily made up of chlorinated solvents that were used for cleaning rocket engine parts prior to the mid-1980s.

Air Force workers started looking for contamination at the AFRL in the early 1990s. They concentrated on places where they knew hazardous materials had been used or stored. Workers drilled to collect soil samples and installed monitoring wells to collect groundwater samples from fractures within the granite bedrock. These samples were sent to analytical laboratories to see what chemicals were present. Soil vapor samples were analyzed on-site. Sampling locations where chemicals were present pointed the cleanup team to the spots where the amounts of contamination were highest.

The major areas in the South AFRL with groundwater contamination were named Site 37, Site 120, Site 133, and Site 321, the locations of which are indicated on Figure 2. The chlorinated solvents tetrachloroethene (PCE) and/or trichloroethene (TCE) are the major contaminants in the groundwater, where they are found both in the dissolved (aqueous) phase and in the form of a dense, non-aqueous phase liquid (DNAPL). The U.S. EPA considers DNAPL a type of "principal threat waste," defined as a highly toxic or highly mobile source material that cannot be reliably contained, and/or that would present a significant risk to human health or the environment should exposure occur. The NCP establishes an expectation that treatment will be used to address principal threat wastes wherever practical.

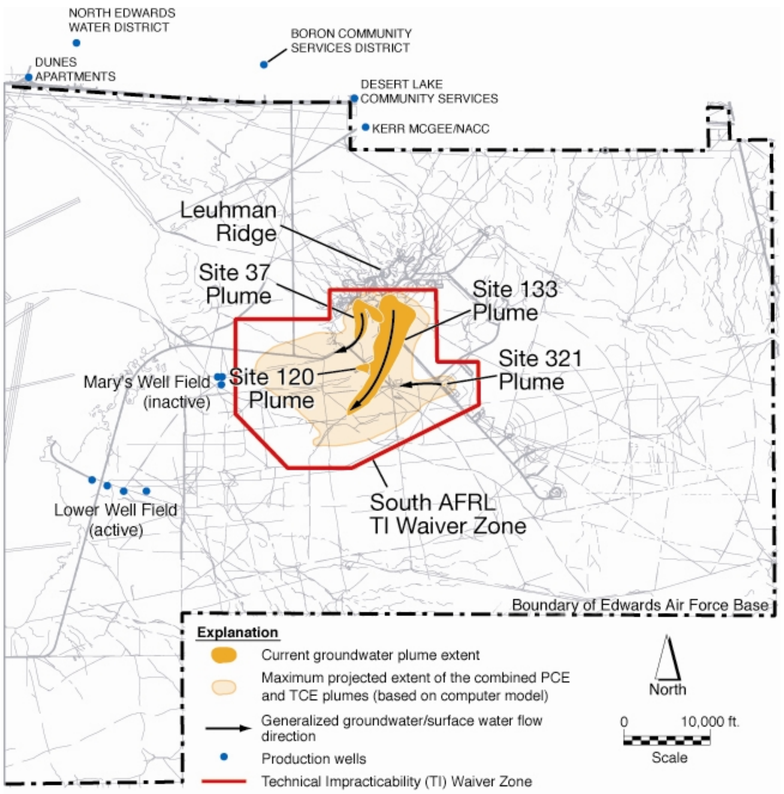


Figure 2 – South AFRL TI Waiver/Containment Zone and Projected Maximum Extent of Contaminants

<u>Site 37</u>

Site 37 is centered around Building 8595, which was used in the past for maintenance and repair of rocket components. These processes involved the use of chemicals, primarily PCE, which were inadvertently spilled or otherwise improperly released, creating a large plume of contaminated groundwater as shown conceptually on Figure 3. At Site 37, the entry point of DNAPL was on the south side of Building 8595, where a large volume of PCE was accidentally spilled from an aboveground storage tank (diluted PCE was also released by sumps inside and outside the building). The DNAPL zone is estimated to affect an area of approximately 6.4 acres and extend to a depth exceeding 250 feet. The dissolved phase plume at Site 37 is estimated to extend approximately 6,000 feet south of Building 8595 and to cover a surface area of approximately 390 acres.

DNAPL is difficult to locate and sample, and has not been directly observed in samples collected at the South AFRL. However, the presence of DNAPL was inferred based on a combination of the site history (reported releases) and dissolved concentrations of PCE and/or TCE in water. DNAPL is suspected to be present at locations where these solvents were detected above 5,000 micrograms per liter (µg/L), a concentration that is approximately 5 percent of the maximum solubility of these chemicals in water. By comparison, the maximum contaminant level (MCL), or maximum allowable concentration in drinking water for either PCE or TCE is 5 µg/L. Following U.S. EPA guidance, the DNAPL entry location, DNAPL zone, and aqueous contaminant plumes were characterized for each site as described below.

<u>Site 120</u>

Site 120 is the AFRL's former sewage treatment plant that began operating in the early 1950s. Before the plant was renovated in 1995, it used an Imhoff tank for settlement of solids. The partially treated waste water was discharged to evaporation ponds and allowed to evaporate or seep into the soil. The water in these ponds contained dissolved solvents (primarily PCE) and other chemicals that were disposed of in sinks and storm drains throughout the AFRL. The entry point of DNAPL (if present) at Site 120 is the former Imhoff tank, with the potential DNAPL zone estimated at 0.09 acres to a depth of 100 feet. The dissolved phase plume is merged with the Site 133 plume.

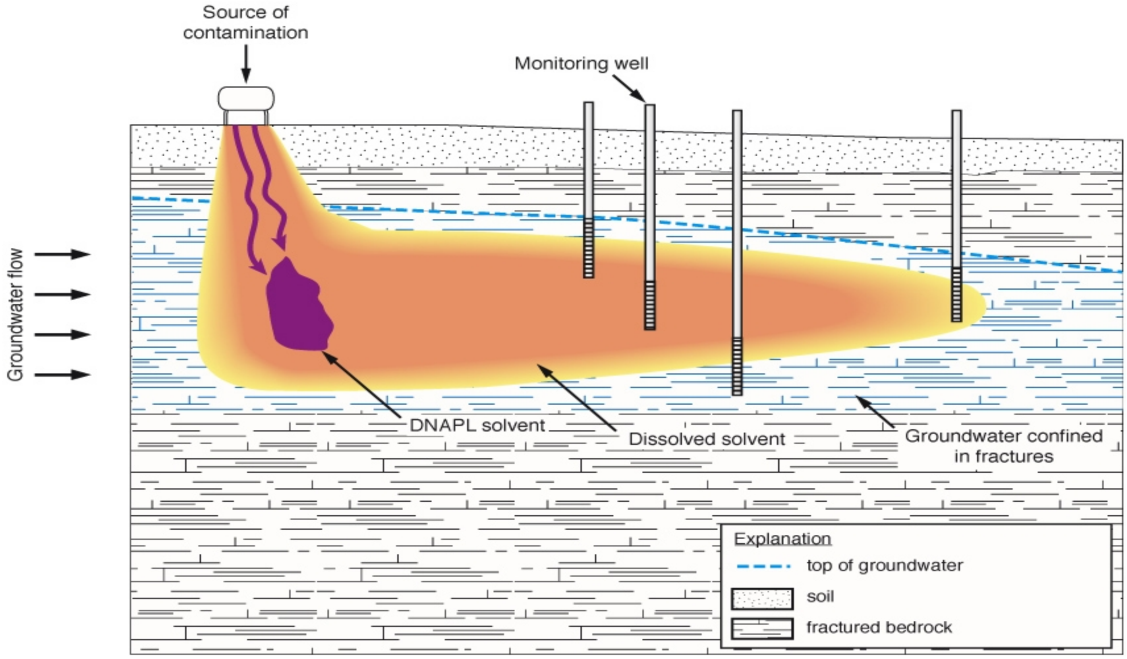


Figure 3 – Conceptual Contaminant Migration

<u>Site 133</u>

Site 133 was first identified as the AFRL's civil engineering yard, but was expanded to include groundwater under: two former waste evaporation ponds associated with the chemistry laboratory (Building 8451); the AFRL gas station; two former waste disposal wells associated with Buildings 8431 and 8424 (which were used for missile assembly); and a former fire training area. Based on sampling data, these are all areas where solvents (primarily TCE) diluted in rinse water were apparently disposed of on the ground or to the subsurface.

The entry points of DNAPL at Site 133 are believed to be the two former waste disposal wells. The DNAPL zone surrounding each of these wells is estimated to affect an area of 0.23 acres to a depth of at least 350 feet. The dissolved phase plume at Site 133 (which also includes Site 120) extends 3.2 miles and is estimated to cover a surface area of approximately 1,500 acres.

<u>Site 321</u>

Site 321 was used as a storage area for liquid rocket propellants (hydrazine and nitrogen tetroxide). Sampling results show that PCE and TCE were released here as well. Three catch tanks, formerly used to contain runoff of excess chemicals and rainwater from nearby buildings, were removed from this area in 1995. Leakage from the tanks (before they were removed) is the source of the groundwater contamination at this site. The entry point of DNAPL (if present) is the former location of the catch tank south of Building 9423. The potential DNAPL zone is estimated at 0.1 acres in area, and extends to a depth exceeding 300 feet. The dissolved phase plume is estimated to extend approximately 1,100 feet and cover a surface area of approximately 11 acres.

Site Characteristics

Based on results of the Remedial Investigation, a conceptual site model was developed for the South AFRL area that includes the following major findings/assumptions:

- Geology in the area is characterized by a thin zone of unconsolidated soils (silty sand) overlying

weathered and competent granite bedrock. The bedrock is highly fractured (has many cracks). At many locations, fractured rock is exposed in surface outcrops.
- Groundwater occurs under hydrostatic pressure within the fractured granite (the level at which groundwater stabilizes in a monitoring well is generally higher by several feet than the level at which groundwater is found during drilling). The hydraulic conductivity, or ease with which groundwater passes through the fractured rock, is generally low.
- Locally, the movement of groundwater and contaminants is along the bedrock fractures. However, at the scale of the area covered by dissolved contaminants, the regional flow of groundwater resembles flow through a porous medium (such as sand or clay). The direction of groundwater flow generally mimics the slope of the overlying ground.
- The PCE and TCE present as DNAPL at each site will continue to slowly dissolve, acting as continuing sources of groundwater contamination.

Source Control Actions

Although there has been no attempt to remove DNAPL from the bedrock at the South AFRL, the following source control actions have been completed at Sites 37, 120, 133, and 321:
- Decommissioned, cleaned, and backfilled the leaking sumps at Building 8595. Replaced the flooring inside the building now used as an electronic propulsion laboratory
- Renovated and upgraded the sewage treatment plant, including taking the former Imhoff tank, sludge drying beds and waste evaporation ponds out of service
- Removed underground storage tanks from the AFRL gas station
- Removed an aboveground storage tank from the former fire training area and excavated petroleum contaminated soil
- Destroyed waste discharge wells by redirecting active inlet lines; cleaning out contaminated soil, sludge and water; and backfilling with cement/sand slurry
- Installed a final cover system at the AFRL landfill
- Removed below grade catch tanks associated with Site 321.

In addition (described in greater detail below), the following treatability studies are ongoing at Sites 37 and 133:
- Operation of a soil vapor extraction (SVE) and treatment system south of Building 8595 since 2000
- Operation of a groundwater extraction and treatment system (GETS) at Site 37 since 1999
- Operation of a GETS at Site 133 since 2001.

The SVE system began operation in May 2000 with a single extraction well located inside the waste sump just south of Building 8595. This system was designed to reduce PCE concentrations in fill sand beneath the sump to a level below its residential Preliminary Remediation Goal (PRG), which at the time was 5.7 milligrams per kilogram (mg/kg) -- an objective that was met within its first year of operation. Residential PRGs are concentration levels published by the U.S. EPA Region IX below which risks to human health are considered acceptable.

Because it was so effective, the SVE system was expanded to a total of seven shallow extraction wells with the goal of removing as much PCE as possible from the subsurface south of Building 8595. In 5 years, this system has removed an estimated 7,000 pounds of PCE at a cost of approximately $90 per pound. As PCE removal becomes more difficult (due to a steep decrease in concentration) and operation of the system becomes less cost-effective, the Air Force plans to shut the system down and collect soil gas samples to measure PCE concentrations remaining in the soil vapor.

In 1998, a small-scale GETS was installed at Site 37 as a treatability study to test whether the spread of contaminated groundwater could be slowed. The system began operation with two extraction wells in January 1999 and was later expanded to include seven extraction wells (including three inside the DNAPL zone). The system was successful in slowing the spread of dissolved contaminants above a targeted PCE concentration of 10,000 µg/L. In 6 years of operation, the system has removed an estimated 450 pounds of PCE at an estimated cost of approximately $3,000 per pound. Due to the continual slow dissolving of PCE from DNAPL into the overlying groundwater, however, it is estimated that the system would be required to operate indefinitely (well over 100 years) to continue to contain the spread of contaminants.

In 2001, a small-scale GETS was installed at Site 133 as a treatability study. This system, like the one at Site 37, was designed to slow the spread of groundwater contamination, and was shown to be effective within its area of influence. The system includes four groundwater extraction wells but operation of the wells is limited by the volume of treated water that can be discharged (treated water is piped to the AFRL sewage treatment plant). In 4 years of operation, the system has removed an estimated 200 pounds of TCE at an estimated cost of $3,500 per pound. As at Site 37, due to the continual slow dissolving of DNAPL (TCE at Site 133), system operation would be required indefinitely (well over 100 years) to continue to contain the spread of contaminants.

Current Extent and Predicted Movement of Contamination

The contaminated groundwater at the South AFRL currently covers an area of approximately 1,900 acres on Edwards AFB (see Figure 2) and extends to depths greater than 300 feet. If it were to be spread out above ground, the contaminated water would fill a 3,000 acre pond to a depth of 1 foot (3,000 acre-feet). By comparison, the total volume of water in the Antelope Valley Groundwater Basin is estimated to be 55 million acre-feet.

The nearest off-base water supply wells (near Boron, CA) are located approximately 4¼ miles from the current outer limit of groundwater contamination; groundwater flow in the South AFRL is generally south, away from these wells. However, the nearest active base water supply wells (in the Lower Well Field) are located approximately 4½ miles from the current outer limit of contamination, in the direction of groundwater flow. Wells in the Lower Well Field are screened in the alluvial aquifer (composed of fine to coarse sand, gravel and boulders) and extract from depths ranging from 327 feet to 525 feet.

A computer model that simulates the spread of groundwater contamination over time was prepared for the South AFRL. This model incorporates reasonable but conservative assumptions that are highly protective of public health, and likely presents a "worst-case" scenario. Results of the modeling, shown on Figure 2, indicate that the groundwater contaminant plume (area shaded a dark orange) will slowly advance for up to 800 years (covering the area shaded a light orange) before natural physical, chemical, or biological processes halt further spread. At its maximum size, the plume is expected to cover an area of 5,600 acres and have a volume of 8,500 acre-feet. The model indicates that neither the active base water supply wells (Lower Well Field) nor the inactive wells in Mary's Well Field (which no longer produce sufficient water to pump) are likely to be contaminated in the future.

To aid in comparing cleanup alternatives for the South AFRL, the following remedial scenarios were also modeled: limited expansion and continued operation of the existing groundwater extraction and treatment systems (GETS) at Sites 37 and 133 to contain spread of groundwater at PCE and TCE concentrations greater than 1,000 µg/L (hot spot containment); installation and operation of a GETS that would contain spread of groundwater at PCE and TCE concentrations above 5 µg/L (plume containment); and removal of all the DNAPL within 10 years. The last scenario is considered hypothetical because no current remedial technologies have been proven effective for 100 percent removal of DNAPL in fractured bedrock (the total volume of DNAPL has not been estimated due to the difficulty of locating and delineating it in the rock). The current extent of the South AFRL plume is shown on Figure 4 and predicted outcomes of no active containment and each of the above scenarios at 100 years and 1,000 years are compared on Figure 5. Note that, although successful application of either of the two active containment scenarios is projected to result in a significantly lower volume of impacted groundwater than no active containment after 1,000 years, these scenarios do not have an endpoint so long as DNAPL continues to be present. As expected, the successful removal of DNAPL would have the best long-term outcome.

Scope and Role of Action

This action, referred to as the South AFRL, will be the final action for Sites 37, 133, and 120 in Operable Unit 4 and Site 321 in Operable Unit 9 (there are 10 operable units for which Proposed Plans have been or will be prepared at Edwards AFB). The South AFRL is the first of several actions to be proposed for sites in Operable Units 4 and 9; preferred alternatives for other actions at Operable Units 4 and 9 will be presented in Proposed Plans for: Soil and Debris Sites; the AFRL Arroyos area; and the Northeast AFRL and Mars Boulevard areas.

Land Use Designation

Land use at the entire AFRL is currently designated for engineering/test, which reflects the mission conducted at the facility. To better support the mission, and to enhance the quality of the workplace, there is a proposal presented in the Air Force Research Laboratory Area Development Plan (Appendix F of the Base Comprehensive Plan) to renovate small parts of the South AFRL for administrative, industrial, and community-commercial (i.e., recreation center) uses. However, there are no plans for residential uses such as housing or schools at the AFRL.

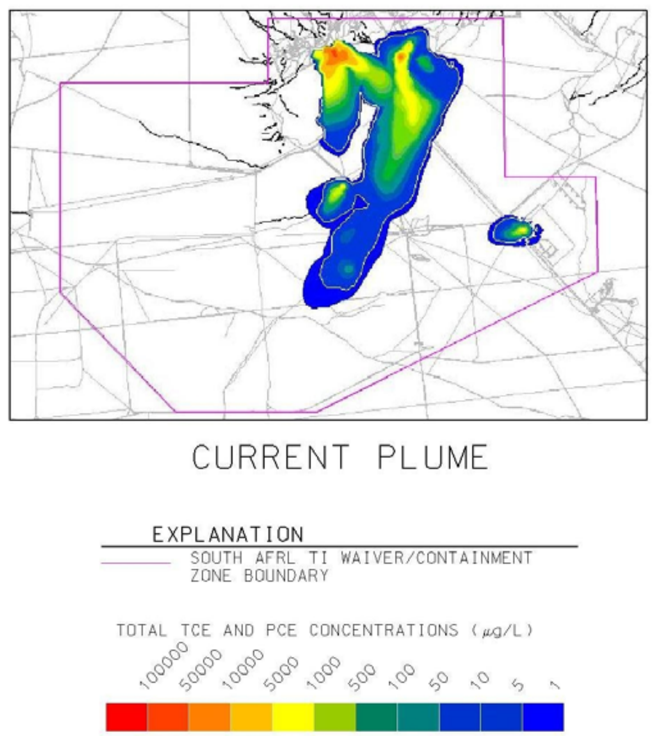
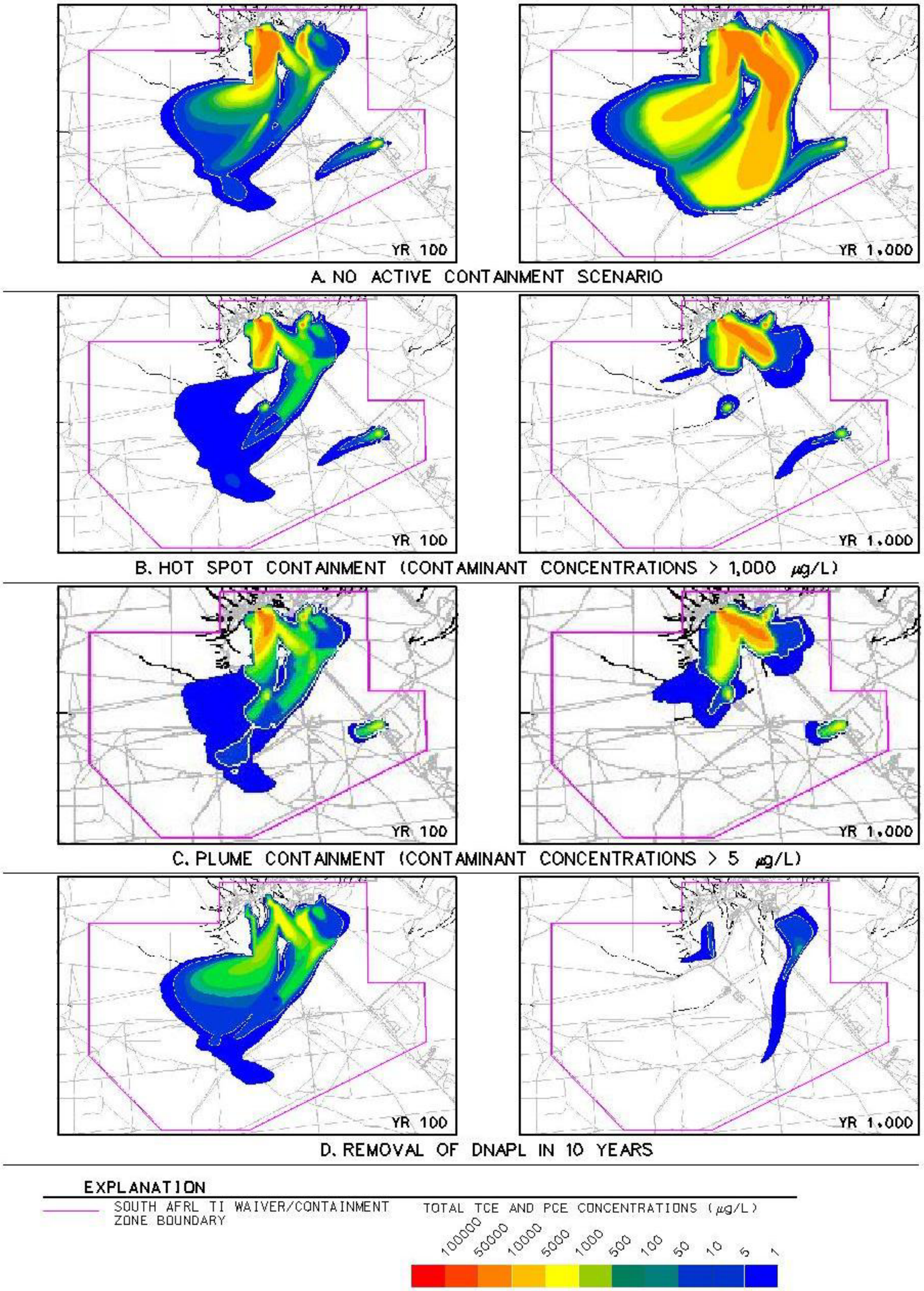


Figure 4 – South AFRL Current Plume Extent

Figure 5 – South AFRL Remedial Scenario Comparison



Summary of Site Risks

For each site, a baseline human health risk assessment (HHRA) and an ecological risk assessment (ERA) were performed to estimate the current and future effects of chemicals detected in the soil and/or the groundwater on human health and the environment. The current and reasonably anticipated future land use at South AFRL is industrial. However, in order to assess whether the sites could be approved for future unrestricted access, the HHRA includes a preliminary evaluation of site risks due to soil and soil vapors under a residential exposure scenario as well as industrial and construction exposure scenarios. Currently, groundwater at the South AFRL is not used for drinking by anyone. Even though the groundwater is not a current drinking water source, it is classified as a "potential drinking water source" by the State of California and the U.S. EPA. Furthermore, the NCP states that "EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site." Therefore, the HHRA includes an estimate of risk to human health under a hypothetical residential exposure pathway.

Results of the HHRA and ERA, described in more detail below, indicate that current risks posed to human or environmental receptors due to chemicals in the soil, soil vapor, or groundwater are acceptable. However, there are unacceptable risks associated with potential hypothetical future use of groundwater as a drinking water source. These risks are due to the chemicals of concern listed in Table 1. It is the Air Force's judgment, as the lead agency, that the Preferred Alternative identified in this Proposed Plan, or one of the other alternatives considered (other than No Action) is necessary to protect human health and the environment from contaminants in the groundwater at South AFRL.

Human Health Risk

To estimate the potential health risk that contaminants at Sites 37, 120, 133, and 321 might pose, a certain level of exposure to site soil and groundwater was assumed. The dose of each chemical received by the hypothetical receptors (e.g., workers at each site) was used to calculate the potential risk for that chemical, and these risks were then summed for all of the chemicals of concern. The estimated risks for carcinogenic (cancer-producing) and non-carcinogenic chemicals were summed separately because their risks are measured in different ways. Theoretical cancer risks are characterized in terms of the incremental probability of an individual developing cancer over a lifetime of exposure to a potential carcinogen. The potential for non-cancer effects is characterized by comparing estimated chemical intakes to those determined to correspond to no adverse health effects. This ratio is termed a Hazard Quotient, and the sum of Hazard Quotients for each chemical is termed the Hazard Index.

To manage environmental risks, the U.S. EPA has developed the following ranges: greater than one additional cancer case in 10,000 is unacceptable; one additional cancer case in 10,000 up to 1,000,000 is considered generally acceptable; and one additional cancer case in 1,000,000 or more people is considered acceptable. A hazard index less than 1 is generally considered acceptable. It should be noted that a Hazard Index greater than 1 does not necessarily mean that an actual adverse health effect will develop, but rather raises a concern of an increased potential for an adverse effect.

A preliminary risk assessment was conducted which was based on very conservative (i.e., health-protective) assumptions. For example, the risk assessment hypothetically assumed that workers at the site would be exposed to the maximum detected concentrations of

Table 1 - Chemicals of Concern in Groundwater at South AFRL

Contaminant	Present at Site(s)	Highest 2003 Level (µg/L)	Federal MCL (µg/L)	California Primary MCL (µg/L)	Cancer Causing?
1,1,1-Tricholorethane	37	1,100	200	200	No
1,1-Dichloroethane	37	120	None	5	Possible
1,2-Dichloroethane	133	3.3	5	0.5	Probable
1,1-Dichloroethene	37	1,900	7	6	No
1,4-Dioxane	37, 133, 120	391	None	3 (NL)	Probable
Benzene	133	38*	5	1	Yes
cis-1,2,-Dichloroethene	37, 133, 120, 321	5,100	70	6	No
Freon 113	37	16,000	None	1,200	No
Methylene chloride	37	650	5	5	Probable
Methyl tert butyl ether (MTBE)	133	290	None	13	Probable
N-nitrosodimethylamine (NDMA)	37, 133	0.0798	None	0.01 (NL)	Probable
Tetrachloroethene (PCE)	37, 133, 120, 321	110,000	5	5	Probable
trans-1,2-Dichloroethene	120, 133	180,000	100	10	No
Trichloroethene (TCE)	37, 133, 120, 321	46	5	5	Probable
Perchlorate	37, 133, 120	18.5	None(1)	6 (NL)	No
Nitrate	321	903*	10 mg/L	10 mg/L	No

*Not detected in 2003. Concentration shown is historic maximum.
(1) Although there is no federal MCL for perchlorate, a drinking water equivalent level of 24.5 micrograms per liter (µg/L) has been derived as a to-be-considered (TBC) criterion from an oral reference dose of 0.0007 mg/kg/day listed in the U.S. EPA's Integrated Risk Information System (IRIS) database.

This table shows the chemicals of concern in the groundwater, which are found at concentrations higher than the safe limits set in the Safe Drinking Water Act. The Safe Drinking Water Act calls their limits Maximum Contaminant Levels, or MCLs in the table. Although groundwater in the South AFRL is not used for drinking, these limits can be used as cleanup goals for "potential" drinking water sources.

California Notification Levels, or NLs in the table, are health-based advisory levels established by the State Department of Health Services for chemicals that lack MCLs. These NLs are TBC criteria when comparing the proposed alternatives against regulations. The symbol µg/L means micrograms per liter, approximately the same as parts per billion. It is the unit of measure used to track contamination in groundwater. One microgram per liter is equal to 1 part contamination and 999,999,999 parts water. The symbol mg/L means milligrams per liter, approximately the same as parts per million, which is equal to 1 part contamination per 999,999 parts water.

contaminants over a 25-year period. In the preliminary evaluation of risk based on hypothetical use of groundwater in a residential setting, cancer risks and non-cancer hazards for all four sites were significantly above the unacceptable range (Table 2). These risk results indicate the importance of ensuring that untreated groundwater at the South AFRL is not used for drinking water in the future.

Risks associated with potential exposure to soil were estimated for three different exposure scenarios: residential, industrial, and construction (Table 3). With the exception of the most conservative (residential) exposure pathway at Site 37, all the estimated risks due to soil exposure fall within the generally acceptable or acceptable range. The estimated cancer risk for Site 37 soil was driven primarily by arsenic. The Hazard Index for Site 37 soil in a residential setting is slightly above 3, due to the detected presence of manganese and iron. However, the only samples in which chemicals were detected above background levels were from deep underground (25 feet), beyond the depth at which routine exposure is likely to occur. Additionally, the site history does not indicate any suspected release of arsenic, iron, or manganese to soil; the elevated concentrations of these elements are believed to be naturally-occurring. Therefore, the Air Force, the U.S. EPA, and state regulators agree that any risks associated with exposure to soils at the four sites (under all scenarios, including residential) fall within the acceptable range, and recommend that soils do not require either land use controls (based on the soil contamination depth) or another remedial action.

Both soil and groundwater can release contaminant vapors into indoor air. To evaluate the risk of exposure from the vapor intrusion pathway, a computer model was used to estimate the concentration of chemicals that might build up in indoor air and the risks they pose under residential and industrial exposure settings. Results, shown in Table 4, indicate that risks due to vapors from soil or groundwater at Sites 37, 120, 133, and 321 all fall within the generally acceptable and acceptable ranges. However, the hazard index via exposure to indoor air at Site 37 was estimated at 2.9 and 2 for residential and industrial exposure settings, slightly above the acceptable range. In June 2003 and again in March and November 2005, indoor air samples were collected inside Building 8595 and tested for PCE. A risk assessment based on the maximum result (4.7 $\mu g/m^3$) from the indoor air sampling, rather than computer-modeled concentrations, indicates a hazard index below 1 and confirms a risk in the generally acceptable range for both residential (1.14×10^{-5}) and industrial (2.71×10^{-6}) exposure scenarios. Based on these results, the Air Force, U.S. EPA, and state regulators agree that risks associated with indoor vapors at the four sites fall within the acceptable range, and recommend that no remedial action is required for vapor intrusion into buildings.

No Risk to Air Force Workers

Although groundwater contamination exists, *there is no risk to the average Air Force worker*. For contamination to harm people, three things must happen.

1. First, there must be enough of the contamination to do harm.
2. Second, there must be people at the site.
3. Third, the people at the site need to come into contact with the contamination. This can be through touching, eating, drinking, or breathing it in.

The contamination in the South AFRL groundwater is located a minimum of 12 feet below the ground surface. Therefore, a person performing normal work would not be able to touch, eat, drink, or breathe it in. Computer modeling and indoor air sampling indicate vapor concentrations inside buildings at the sites are within the generally acceptable and acceptable ranges; adequate ventilation lowers the risk further. It is important to note that there is no housing at the AFRL (current or planned for the foreseeable future) and no current use of the contaminated groundwater. Furthermore, the AFRL restricts access only to site workers and employs other land use controls, as discussed below, to ensure that utility or other workers who may be required to work in the affected area will not be exposed to contaminants in the groundwater.

Existing Land Use Controls

The Air Force already restricts public access to the South AFRL through the use of fences, manned gates, passes, and security patrols. The Base Comprehensive Plan (BCP) documents the systems by which public versus restricted access is coordinated. Furthermore, all construction and/or digging projects on base require approval from Environmental Management and Civil Engineering in the form of a digging permit (Form 103) and/or a contract by requestor permit (Form 332). The project managers at Edwards AFB, or their delegates, are required to check the Edwards AFB Geographic Information System (GIS) before approving such projects. The GIS includes land use control components

Table 2 - Health Risks Associated with the Hypothetical Potential Use of Groundwater at South AFRL as a Drinking Water Source

Site	Potential Exposure Pathway	Contaminant(s) Causing the Most Risk	Hypothetical Health Risk
37	Residential	See Table 1 – Chemicals of Concern in Groundwater	A cancer risk of 2.28x10^{-1} and a non-cancer hazard of 445.
133	Residential		A cancer risk of 1.53x10^{-2} and a non-cancer hazard of 216.
120	Residential		A cancer risk of 3.83x10^{-3} and a non-cancer hazard of 674.
321	Residential		A cancer risk of 4.24x10^{-3} and a non-cancer hazard of 119.

*The initial screening was based on maximum detections and assumed use of groundwater as a drinking water source.

Table 3 - Health Risks Associated with Potential Exposure to Soil at South AFRL

Site	Potential Exposure Pathway	Contaminant(s) Causing the Most Risk	Hypothetical Health Risk
37	Residential	c: arsenic[1] nc: manganese and iron[1]	A cancer risk of 1.32x10^{-4} and a non-cancer hazard of 3.609.
	Industrial		A cancer risk of 1.88x10^{-5} and a non-cancer hazard of 0.447.
	Construction		A cancer risk of 2.90x10^{-7} and a non-cancer hazard of 0.172.
133	Residential	c: total chromium nc: manganese	A cancer risk of 7.46x10^{-8} and a non-cancer hazard of 0.432.
	Industrial		A cancer risk of 3.49x10^{-8} and a non-cancer hazard of 0.022.
	Construction		A cancer risk of 5.37x10^{-10} and a non-cancer hazard of 0.009.
120	Residential	c: total chromium nc: silver	A cancer risk of 7.01x10^{-8} and a non-cancer hazard of 0.048.
	Industrial		A cancer risk of 3.29x10^{-8} and a non-cancer hazard of 0.002.
	Construction		A cancer risk of 5.05x10^{-10} and a non-cancer hazard of <0.001.
321	Residential	c: total chromium nc: copper and mercury	A cancer risk of 1.04x10^{-7} and a non-cancer hazard of 0.034.
	Industrial		A cancer risk of 4.28x10^{-8} and a non-cancer hazard of 0.003.
	Construction		A cancer risk of 6.57x10^{-10} and a non-cancer hazard of 0.001.
Abbreviations:			
c: cancer risk		nc: non-cancer hazard	

[1] Arsenic, manganese, and iron were detected above background levels only in soil samples collected from 25 feet below the ground surface, beyond the depth at which routine exposure is likely to occur. Additionally, the site history does not indicate any suspected release of arsenic, iron, or manganese to soil; the elevated concentrations of these elements are believed to be naturally-occurring (see discussion on page 11).

* The initial screening was based on maximum detections.

Table 4 - Health Risks Associated with Potential Indoor Vapors at South AFRL

Site and Vapor Source	Potential Exposure Pathway	Contaminant(s) Causing the Most Risk*	Hypothetical Health Risk
37 Soil	Residential	PCE	A cancer risk of 1.73×10^{-6} and a non-cancer hazard of 0.002.
	Industrial	PCE	A cancer risk of 4.11×10^{-7} and a non-cancer hazard of 0.014.
37 GW	Residential	PCE; 1,1-DCE; TCE	A cancer risk of 2.64×10^{-4} and a non-cancer hazard of 2.901.[1]
	Industrial	PCE; 1,1-DCE; TCE	A cancer risk of 6.28×10^{-5} and a non-cancer hazard of 2.072. [1]
133 Soil	Residential	TCE	A cancer risk of 2.34×10^{-6} and a non-cancer hazard of <0.001.
	Industrial	TCE	A cancer risk of 7.43×10^{-6} and a non-cancer hazard of <0.001.
133 GW	Residential	TCE	A cancer risk of 1.77×10^{-6} and a non-cancer hazard of 0.014.
	Industrial	TCE	A cancer risk of 1.77×10^{-6} and a non-cancer hazard of 0.010.
120 Soil	Residential	Methylene Chloride	A cancer risk of 6.09×10^{-7} and a non-cancer hazard of <0.001.
	Industrial	Methylene Chloride	A cancer risk of 1.45×10^{-7} and a non-cancer hazard of <0.001.
120 GW	Residential	PCE	A cancer risk of 2.96×10^{-6} and a non-cancer hazard of 0.034.
	Industrial	PCE	A cancer risk of 7.04×10^{-7} and a non-cancer hazard of 0.024.
321	Groundwater	PCE	A cancer risk of 2.68×10^{-7} and a non-cancer hazard of 0.009.

Abbreviations:

DCE	dichloroethene	TCE	trichloroethene
PCE	tetrachloroethene	GW	groundwater

*After an initial screening, only the chemicals listed above required a detailed Human Health Risk Assessment.

[1]The risks for both residential and industrial exposure pathways were further evaluated based on the maximum concentration of PCE detected during indoor air sampling. The results yielded a hazard index less than 1 and confirmed a cancer risk within the generally acceptable range (see discussion on page 11).

Explanation for Possible Health Risks:

A cancer risk of less than 1×10^{-6} (or one additional case of cancer for 1 million people exposed) is considered acceptable, and cancer risks within the range of 10^{-4} and 10^{-6} are considered generally acceptable when site-specific circumstances allow. A non-cancer hazard of less than 1 is considered safe. Estimated risks above 10^{-4} and estimated hazards above 1 are shown in red in Tables 2, 3, and 4.

showing which areas of the base are contaminated, and therefore should not be disturbed without proper protection such as the use of personal protective equipment (PPE) including wearing masks and protective clothing or using ventilation systems. The BCP and GIS also document restrictions on uses for unsuitable purposes (such as residential use, frequent occupancy, or tapping the aquifer as a drinking water source).

No Risk to Wildlife

Technical experts completed ecological risk assessments for the sites at the South AFRL.

The industrial nature of the South AFRL makes for poor wildlife habitat. No endangered species have been identified in the area, but desert tortoises, a threatened species, can be present at a low density.

Some potential risks to wildlife were identified due to inorganic elements detected at concentrations exceeding their calculated background limits in soil or groundwater; however, after evaluating the distribution and magnitude of these detections at each site, and taking into consideration the fact that there is no evidence of their release as part of site activities, the Air Force, U.S, EPA, and state regulators agreed that these inorganic elements likely do not indicate a release but rather represent the high end of concentrations that are naturally occurring. The reader is referred to the Focused Feasibility Study for the South AFRL, which is available in the Administrative Record for Edwards AFB, for documentation on these types of “risk management” decisions.

PCE via groundwater at Site 37 (at depths less than 25 feet) was identified as posing a risk to terrestrial plants; groundwater over most of the site is encountered at a depth of 50 feet or greater. Several volatile organic compounds via soil vapor at Site 120 were identified as posing potential risks to burrowing small and carnivorous mammals. However, a validation study at Sites 37 and 133 that involved the measurement of soil vapors in artificial burrows and analyses of tissue damage to reptiles and mammals concluded that there were no adverse impacts on small mammal and reptile populations. Therefore, potential risks to ecological receptors are not considered significant at the South AFRL.

No Further Action for Soils or Indoor Air

The Air Force, U.S. EPA and State of California recommend that No Further Action is necessary for soils, soil vapor, or indoor air at Sites 37, 120, 133, and 321. The reason for this recommendation is primarily the acceptable risk to human health and the environment. In addition, the risk assessment process used is extremely conservative in nature. The inorganic elements contributing to human health risk in soil at Site 37 appear to be naturally occurring and are located at depths that create an acceptable risk of exposure. Based on vapor samples collected inside Building 8595, indoor air concentrations of PCE and other chemicals of concern are very low, and any risk they pose is within the acceptable range for the residential exposure scenario.

Evaluation of the Restoration Potential for Groundwater at the South AFRL

In accordance with U.S. EPA guidance for groundwater sites, particularly those where DNAPL is present, the potential for restoration of the groundwater to drinking water standards (MCLs) was evaluated prior to setting remedial action objectives for the South AFRL (cleanup to non-detectable levels was also evaluated). Due to its low solubility and tendency to cling to the bedrock fractures, DNAPL at the South AFRL cannot readily be removed from groundwater using current technologies.

The outcome of this evaluation, which is presented in the focused Feasibility Study, was the conclusion that cleanup of groundwater at the South AFRL to drinking water standards (or to non-detectable levels, which are lower than MCLs) is technically impracticable from an engineering perspective.

The Air Force therefore has proposed a waiver of certain Applicable or Relevant and Appropriate Requirements (ARARs) (refer to glossary) for cleanup of groundwater to a depth of 500 feet in an 18-square mile area, identified as the South AFRL Technical Impracticability (TI) Waiver/Containment Zone (as seen in Figure 2). This area includes the current extent of the contamination and allows for projected further migration of the contaminants until the plume is contained by natural processes without increasing risk to human health or the environment.

What is a TI Waiver? A Containment Zone?

In the case of the South AFRL, a TI waiver is a decision made jointly by the Air Force and U.S. EPA (with concurrence from the state regulators) to allow contaminants in the groundwater within the designated zone to exceed the MCLs established by the Safe Drinking Water Act, or other health-based goals for chemicals without MCLs. These contaminants are listed in Table 1. The protectiveness of the remedy will be ensured through a long-term monitoring program and land use controls. The long-term monitoring program is designed to detect releases from the TI Waiver/ Containment Zone and monitor the rate of migration of contaminants. This program will alert the Air Force to possible failure of one of the remedy components. A TI Waiver is both necessary and appropriate because the best technologies currently available cannot effectively remove or treat the contamination.

A Containment Zone in the State of California, as defined by Section III.H of State Water Resources Control Board (SWRCB) Resolution 92-49, is a specific water-bearing unit in which the CRWQCB finds it is unreasonable to remediate groundwater to the level that achieves water quality objectives (WQOs). Migration of contaminants beyond the Containment Zone boundaries must be prevented. The Air Force proposes that the same area designated for a TI waiver of ARARs also serve as a Containment Zone in the State of California according to Resolution 92-49 Section III.H.

The DNAPL zones identified at Sites 37, 133, 120, and 321 are located within the South AFRL TI Waiver/Containment Zone. Cleanup of the DNAPL, a principal threat waste, will also be waived because source treatment is not practicable with available technology.

If chosen, the TI waiver will be reviewed at least every 5 years as required by CERCLA to determine if the remedy is still protective. Also during the 5-year reviews, a decision will be made as to whether or not technology has progressed enough to allow cost-effective treatment of the contaminants.

Remedial Action Objectives: Goals for Managing Risks at South AFRL

The overall objective of the South AFRL action is to reduce, to acceptable levels, future risks associated with contaminants in groundwater that were identified during the remedial investigation. There are no current risks associated with these contaminants because the groundwater is not being used: the Preferred Alternative will ensure no future use of the groundwater.

The team evaluating long-range management of groundwater contamination at the South AFRL established area specific remedial action objectives (RAOs) to guide development of cleanup alternatives for the groundwater. According to CERCLA guidance, RAOs should specify:

- **The contaminants and media of concern**: The chemicals of concern are listed in Table 1. The medium of concern is groundwater.
- **Exposure route(s) and receptor(s):** There are no current complete exposure routes for any receptors. However, because groundwater at the South AFRL is considered a potential source of drinking water, future exposure routes would include use of groundwater as a drinking water source.
- **An acceptable level or range of levels for each exposure route:** For use of groundwater as drinking water, the acceptable contaminant level for each

contaminant would be its MCL (or other health-based goal for chemicals without an MCL). The CRWQCB has set a water quality objective of cleanup to background or the best water quality which is reasonable and technically and economically feasible. However, as described above, cleanup of groundwater at the South AFRL to drinking water standards is technically impracticable from an engineering perspective. Therefore, cleaning the groundwater to lower levels (e.g., non-detectable, which would be less than 1 μg/L in the case of chlorinated solvents) would also be technically and economically unfeasible. These limitations provide the justification for a TI waiver of ARARs to meet drinking water standards or more stringent water quality objectives, and also provide the rationale for designation of a Containment Zone as defined by California SWRCB Resolution 92-49 Section III.H.

The U.S. EPA recommends the following general strategy for DNAPL sites:

- Prevent further spread of the groundwater contaminant plumes (concentrations above the MCL)
- Prevent further spread of hot spots in the groundwater contaminant plumes
- Reduce the quantity of DNAPL
- Restore the maximum area of the aquifer to cleanup levels that are appropriate for its beneficial uses (aquifer restoration).

The cleanup alternatives presented in this Proposed Plan were developed to meet the above strategy with the exception that a TI waiver of ARARs rather than aquifer restoration was assumed, based on the previous demonstration that cleanup of groundwater to drinking water standards is technically impracticable.

Summary of Remedial Alternatives

Base workers are evaluating five different ways to manage the contaminated groundwater to protect people, wildlife, and the future use of the groundwater. Because the Air Force has demonstrated that cleanup of the groundwater to MCLs is technically impracticable, all options (except for No Action) include a TI Waiver and a Containment Zone Designation in the area shown on Figure 2. Beginning on page 19, each alternative is compared against the nine remedy selection criteria required by law. The Focused Feasibility Study for the South AFRL, completed in June 2005, provides more detail.

The five cleanup alternatives proposed by the Air Force are:

1. **No Action**
   This alternative is listed only to compare to the others. Under this alternative, the plume is expected to grow from its current extent (refer to Figure 4) with no further monitoring or other controls. The existing treatment systems would be shut down. This alternative would cost nothing.

2. **TI Waiver, No Active Containment, Long-Term Monitoring (LTM) and Land Use Controls (LUCs)**
   This alternative relies on the low hydraulic conductivity of groundwater in the fractured bedrock to limit and eventually stop the spread of contaminants within the TI Waiver/Containment Zone, within which the groundwater would not meet drinking water ARARs (MCLs) in a reasonable timeframe (for comparison purposes, see the modeling scenario on Figure 5A). Under this alternative, the contaminant plume may migrate and spread within the TI Waiver/Containment Zone; however, the situation will be monitored to verify that contaminated groundwater is not migrating outside of this area. This alternative uses long-term monitoring (LTM) and land use controls (LUCs), which are described under Alternative Common Components (see page 18), to prevent exposure to

contaminated groundwater. The existing treatment systems at Sites 37 and 133 would not be operating; however, they would be maintained for potential reactivation in the future. LTM and LUCs associated with this alternative would extend indefinitely (beyond 100 years) and cost $2.6 million dollars for the first 30 years. Continued LTM and LUCs beyond 30 years would mean continuing costs beyond $2.6 million.

3. **TI Waiver, Hot Spot Containment (Source Control), LTM and LUCs**
This alternative uses the same controls as Alternative 2, with the added condition of limited expansion and long-term operation of the existing groundwater extraction and aboveground treatment systems at Sites 37 and 133 to achieve hot spot containment (source control) of contaminants at concentrations greater than 1,000 µg/L. The treatment systems will be used to remove contaminants and lessen their overall concentration in the plume; however chemicals in the groundwater would not meet ARARs (e.g., MCLs) in a reasonable timeframe. The spread of the plume would be less than in Alternative 2, as long as the systems continued to extract groundwater (for comparison purposes, refer to Figure 5B). Based on results of computer modeling, this alternative would need to be continued indefinitely (for more than 100 years) and cost $16.7 million dollars for the first 30 years. Continued LTM, LUCs, and operation of the treatment systems beyond 30 years would mean continuing costs beyond $16.7 million.

4. **TI Waiver, Source Area Treatment, LTM and LUCs**
This alternative uses the same controls as Alternative 2, with the added component of aggressive treatment over the first 10 years to remove DNAPL. It should be noted that the successful application of DNAPL removal or treatment technologies in fractured granite is unproven. However, for costing purposes, the following experimental technologies were assumed: blast fracturing followed by in situ treatment and water flushing. Blast fracturing is a process in which explosive charges are placed into the rock and detonated in an attempt to create more fractures through which groundwater can travel. If successful this process can enhance both extraction of contaminated groundwater and injection of chemicals or bioremediation reagents to help degrade the contaminants in place (in situ). Blast fracturing would be used to create extraction and injection “galleries,” or treatment cells within the source area. Water flushing is a process in which water is pumped from an extraction gallery, treated and potentially amended with chemical and/or biological reagents, and returned to the source area through the injection gallery. The purpose is to accelerate the destruction, dissolution, and removal of the DNAPL mass. Any source contaminants (DNAPL) remaining after treatment would continue to dissolve into the groundwater. Due to many uncertainties regarding the effectiveness and implementability of the blast fracturing and water flushing technologies, costs for the source treatment component of this alternative were developed only for the DNAPL zones at Sites 37 and 133. Based on results of computer modeling, even if DNAPL removal at all sites was 100 percent successful, chemicals of concern would not meet ARARs (e.g., MCLs) throughout the dissolved phase plume in a reasonable timeframe (for comparison purposes, refer to Figure 5D). LTM and LUCs following the 10-year source area treatment would continue indefinitely (for more than 100 years). The cost for source area treatment, LTM and LUCs is estimated at $25.4 million for the first 30 years. Source area treatments at the other two sites, and continued LTM and LUCs beyond 30 years, would mean continuing costs beyond $25.4 million.

5. **TI Waiver, Source Area Treatment, Plume Containment at Drinking Water Levels, LTM and LUCs**
This alternative combines all of the elements of Alternative 4 with operation of a groundwater extraction and treatment system designed to prevent migration of the dissolved phase contaminant plumes (concentrations above 5 µg/L). Obtaining this level of plume containment would require the installation of approximately 60 new extraction wells located outside of the currently contaminated area. By comparison of Figures 5B and 5C, one can see that results of computer modeling indicate little advantage to selecting this containment alternative over containment of the hot spot. As with Alternative 4, costs for the source treatment component were developed for the DNAPL zones only at Sites 37 and 133. The cost for source area treatment, plume containment, LTM and LUCs is estimated at $48.5 million for the first 30 years. Source area treatments at the other two sites, and continued plume containment, LTM and LUCs beyond 30 years, would mean continuing costs beyond $48.5 million.

Alternative Common Components

With the exception of the No Action alternative, all of the other alternatives include four major components.

1. TI Waiver of drinking water standards within the South AFRL TI Waiver/Containment Zone.
2. Long-term monitoring (LTM) of the Sites 37, 133, 120 and 321 groundwater plumes using the existing network of monitoring and guard wells to track plume size and location.
3. Contingency for further action if future monitoring of the guard wells indicates potential migration of groundwater contaminants outside the TI Waiver/Containment Zone. In the near-term, part of the contingency is to maintain the existing treatment systems at Sites 37 and 133 in an operable condition so that they may be turned on at any given time.
4. Land use controls (LUCs) to ensure groundwater is not used as a drinking water source and to prevent unprotected contact with contaminated groundwater.

The Air Force will be responsible for implementing, maintaining, monitoring and enforcing the LUCs. As described on page 12, the Air Force already restricts public access to the sites through the use of fences, manned gates, passes, and security patrols. Furthermore, all construction and/or digging projects on base, including wells and other subsurface disturbances that may contact contaminated groundwater, require an approved digging permit and/or a contract by requestor permit. The project managers at Edwards AFB, or their delegates, are required to check the Edwards AFB GIS before approving such projects. LUCs also include prohibitions on use of contaminated groundwater, which may include prohibitions against drinking the water, installing new potable water wells, and using groundwater from existing wells for irrigation of crops or livestock. In the future, any land use restriction imposed at the South AFRL will be formally annotated in the Base Comprehensive Plan (BCP).

The Air Force will conduct annual compliance audits to assess the effectiveness of the LUCs, and the results of each audit will be presented in an annual compliance report. If it is determined that someone has violated the land use controls, the Air Force will take action as soon as practical to address the situation. In addition, the Air Force will notify the U.S. EPA and California regulators as soon as practical after discovering the breach (not to exceed 10 days). The Air Force will give the U.S. EPA and California regulators advance notice prior to transferring property subject to LUCs.

It is expected that the LUCs will be required long-term. As new treatment technologies are developed, it may become feasible to restore parts of the South AFRL TI Waiver/Containment Zone for unrestricted use, eliminating the need for LUCs in those areas. However, the Air Force will not modify or terminate land use controls without concurrence by the U.S. EPA and California regulators.

Evaluation of Alternatives

The Air Force looks at nine criteria established by the U.S. EPA when choosing a remedial alternative as listed below.

1. **Overall Protection of Human Health and the Environment –** This criterion is used to evaluate the ability of an alternative to eliminate, reduce, or control the risks associated with contaminants and exposure pathways. This is a threshold criterion that must be met by the selected alternative.

2. **Compliance with ARARs –** This is another threshold criterion that either must be met, or grounds must be provided for invoking a waiver of specific ARARs. Due to technical impracticability from an engineering perspective, none of the alternatives would allow groundwater within the TI Waiver/Containment Zone to meet the MCLs or other health-based goals, or WQOs set by the CRWQCB, for the contaminants of concern. Therefore none comply with the Safe Drinking Water Act or State requirements for groundwater quality. This is why a TI Waiver for those specific ARARs, and a Containment Zone according to California SWRCB Resolution 92-49 Section III.H, are proposed in the area outlined in red on Figure 2. The Focused Feasibility Study for the South AFRL provides a more detailed description of the ARARs as well as justification for the TI waiver and Containment Zone.

3. **Long-Term Effectiveness and Permanence –** This balancing criterion is used to evaluate the ability of an alternative to protect human health and the environment after remedial action is complete.

4. **Reduction of Toxicity, Mobility, or Volume through Treatment –** This criterion considers the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume of the contaminants.

5. **Short-Term Effectiveness –** This criterion is used to evaluate the protectiveness to human health and the environment during the construction and implementation of an alternative.

6. **Implementability –** This criterion is used to evaluate the technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility is the level of difficulty to implement an alternative at the South AFRL, the reliability of the technology or technologies associated with the alternative, unknowns associated with the alternative, and the need for studies. Administrative feasibility is the regulatory agency concurrence, the need for permits or waivers, and the need for land use restrictions. Availability of services and materials includes mobilization requirements, accessibility to equipment, availability of materials, and availability of trained personnel required to implement the alternative.

7. **Cost –** The last of the five balancing criteria, cost considerations include capital costs and present value costs. Capital costs are the costs associated with the implementation of an alternative. These include direct costs

Table 5 – Present Value Costs

Costs (Present Value)	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Capital	$0	$0	$10,960,000	$18,000,000	$39,500,000
Long Term Monitoring	$0	$2,410,000	$2,410,000	$5,100,000	$5,100,000
Operation and Maintenance	$0	$100,000	$3,270,000	$2,200,000	$3,800,000
Land Use Controls	$0	$70,000	$70,000	$74,000	$74,000
Total	**$0**	**$2,580,000**	**$16,710,000**	**$25,374,000**	**$48,474,000**

(equipment, labor, and materials for remedial action implementation) and indirect costs (engineering and other costs not directly associated with construction). As shown in Table 5, present value costs are used for comparative analysis. Alternative 1 has the lowest estimated present value cost ($0) and Alternative 5 has the highest present value cost ($48.5 million for the first 30 years).

8. **State/Support Agency Acceptance –** This modifying criterion is used to address technical and administrative concerns that the agencies may raise during the review process. The Air Force has incorporated revisions to the Focused Feasibility Study and the Proposed Plan in response to review comments by the U.S. EPA and the State of California regulators. Alternative 2, as presented in this Proposed Plan, has the support of the U.S. EPA and State regulators.

9. **Community Acceptance –** This modifying criterion is used to evaluate the concerns that the public may have and the anticipated level of acceptance by the public. Community acceptance of the Preferred Alternative will be evaluated after the public comment period ends.

In determining the most cost-effective remedy, the performance of each alternative that met the threshold criteria was compared against the following three balancing criteria: long-term effectiveness and permanence; reduction of contaminant toxicity, mobility, or volume through treatment; and short-term effectiveness. While Alternatives 3, 4, and 5 could potentially provide an incremental reduction in the extent of contamination, none of the alternatives would attain the goal of reducing the contamination below MCLs or WQOs. Even if the other alternatives achieved ideal results, in the near term (100 years) the best among them would provide only slightly better containment of the plume than Alternative 2. Given this fact and the fact that with the implementation of land use controls no exposures would be likely to occur, the incremental benefits provided by Alternatives 3 through 5 are not proportionate to their significantly greater costs.

Alternative 2 is Preferred

Based on an evaluation of the remedial alternatives against the nine criteria listed above, Alternative 2 is preferred as the proper course of action with regard to the contaminated groundwater (Table 6).

Before making this determination, containment of the contaminant plume by extracting groundwater across its current outer limit was carefully considered. Although plume (or hot spot) containment to prevent further migration of contaminants can be achieved, there are serious limitations to this remedial strategy, the most significant of which is that the plume as a whole remains untreated. Perpetual operation of groundwater extraction and treatment systems is not considered a cost-effective or practical option. Another drawback is that it is not clear that the measure is necessary. Because no groundwater supply wells have yet been impacted, exposure pathways are incomplete. Additionally, computer simulation of contaminant transport suggests that no impact to active water supply wells is anticipated over the next 1,000 years even if no active containment measures are taken. Removal of DNAPL as a principal threat

Table 6 - Evaluation of Alternatives Summary

KEY ○ Does not meet criteria ◒ Partially meets criteria ● Meets Criteria	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3	Alternative 4	Alternative 5
Overall protection of human health and the environment	○	●	●	●	●
Compliance with ARARs or justification for a waiver.*	○	●	●	●	●
Long-term effectiveness and permanence	◒	●	●	●	●
Reduction of toxicity, mobility, or volume through treatment	○	○	◒	●	●
Short-term effectiveness	●	●	●	○	○
Ability to implement	●	●	●	○	○
Cost	●	●	◒	○	○
State acceptance	The U.S. EPA and State of California concur with the Preferred Alternative				
Community acceptance	To be determined through public comment, with the final result recorded in the Record of Decision				

Alternative 1 – No Action
Alternative 2 – Technical Impracticability (TI) Waiver with Land Use Controls (LUCs) and Long-Term Monitoring (LTM) of Groundwater
Alternative 3 – TI Waiver with LUCs, LTM and Hot Spot Containment
Alternative 4 – TI Waiver with LUCs, LTM, Hot Spot Containment, and Source Area Treatment
Alternative 5 – TI Waiver with LUCs, LTM, Plume Containment at Drinking Water Standards, and Source Area Treatment

*Justification for a TI Waiver of ARARs was provided in detail in the Focused Feasibility Study for the South AFRL. The justification is based on the fact that best available treatment technologies have not been demonstrated capable of cleaning up solvents in fractured bedrock to MCLs.

waste in the source area remains a desirable goal – computer simulation suggests that source removal would result in a significant reduction of contaminant concentrations throughout the dissolved phase plume. The removal of source area DNAPL, however, relies on technologies that are largely unproven in the challenging aquifer conditions at the South AFRL. Until the performance of one or more innovative treatment technologies can be adequately evaluated in small-scale pilot tests, selection of a source area treatment technology (anticipated to be very costly and only partially effective) would be premature.

The establishment of the 18-square mile TI Waiver/Containment Zone, with groundwater monitoring to confirm that no contaminants spread outside of the zone and land use controls to prevent use of groundwater as a drinking water source, will protect human health and the environment while working within current technological limitations.

In addition, Alternative 2 represents the most cost-effective use of taxpayer dollars. Because the hazardous material will remain onsite, the selection of this alternative will be reviewed every five years, as required by law, to ensure that the alternative is still protective of human health and the environment.

To summarize, the components of the preferred remedy are listed below:

1. A TI waiver of certain ARARs and Containment Zone in the area shown on Figure 2. The area is wholly within the Edwards Air Force Base boundary and does not include any water supply wells.
2. No active plume containment. Reliance on the low hydraulic conductivity of groundwater in the fractured bedrock to limit and eventually stop the spread of contaminants within the TI Waiver/Containment Zone.
3. Long-term monitoring (LTM) to verify that contaminated groundwater is not migrating outside of this area.
4. Land use controls (LUCs) to prevent exposure of workers to subsurface groundwater contamination and to prevent future use of contaminated groundwater as a drinking water source.
5. Shutdown of the existing GETS systems at Sites 37 and 133. These systems will be maintained such that they can be returned to operation as part of future technology testing or as part of a contingency plan triggered by monitoring results.

Volume II of the Focused Feasibility Study for the South AFRL presents a Management Plan that describes the LTM and LUC components of the Preferred Alternative in detail. The Management Plan also identifies triggers for further action and outlines the contingency measures that will be taken if contaminant migration is confirmed at a higher rate than projected by the groundwater modeling. Contingencies include reactivating the Site 37 and/or Site 133 groundwater extraction and treatment system(s) as an interim measure pending implementation of a formal contingency plan unless an alternative interim contingency measure is proposed within 90 days. Within 180 days of the triggering event, the Air Force will propose an alternate remediation and/or containment measure(s), based on contemporary site conditions and current best available technologies.

Based on information currently available, the lead agency believes the Preferred Alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The Air Force expects the Preferred Alternative will satisfy the following statutory requirements of CERCLA § 121(b), to: 1) be protective of human health and the environment; 2) justify a waiver of ARARs; 3) be cost-effective; 4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and 5) satisfy the preference for treatment as a principal element (or justify not meeting the preference).

Community Participation

The Air Force provides information regarding the cleanup of the South AFRL to the public through the Restoration Advisory Board, the Administrative Record file for the site, the Environmental Management website (http://www.edwards.af.mil/penvmng/aboutedwards/EM.html), and the monthly publication ***Report to Stakeholders***.

The Air Force encourages the public to gain a more comprehensive understanding of the South AFRL and the cleanup activities that were conducted there. All the documents that the base has used to make decisions about cleanup at the South AFRL are in the base's administrative record. If you would like to view the full administrative record, you must make an appointment with Gary Hatch during regular business hours.

- Address: 95 ABW/PAE
  Attn: Gary Hatch
  5 E. Popson Ave, Bldg. 2650A
  Edwards AFB, CA 93524-8060
- Phone: (661) 277-1454
- Fax: (661) 277-6145
- E-mail: Gary.Hatch@edwards.af.mil
- Hours: By appointment only,
  Monday through Friday
  8 a.m. to 4:30 p.m.

To view a subset of decision documents, you may also visit one of the other three locations listed in the box below.

To Make a Comment

Comments can be made at the public meetings or you can mail, e-mail, or fax your comments on the South AFRL Proposed Plan to Gary Hatch using the contact information above. A form is provided on page 25, but written comments can be in any form.

How to Get More Information

If you want more information regarding the underground contamination at the South AFRL, you can read the technical documents regarding this site, which can be found at the following locations:

Edwards AFB Library (complete record)
5 West Yeager Boulevard
Building 2665
Edwards AFB, CA 93524-1295
(661) 275-2665

Kern County Public Library (partial record)
Wanda Kirk Branch
3611 West Rosamond Boulevard
Rosamond, CA 93560
(661) 256-3236

Los Angeles County Public Library (partial record)
601 West Lancaster Boulevard
Lancaster, CA 93534
(661) 948-5029

Twenty Mule Team Museum (partial record)
26962 20 Mule Team Road
Boron, CA 93516-1560
(760) 762-5810

OR you can contact:

Nicole Moutoux, Project Manager
US EPA
(415) 972-3012
Moutoux.nicole@epamail.epa.gov

John Harris, Project Manager
DTSC
(916) 255-3683
jharris3@dtsc.ca.gov

Kai Dunn, Project Manager
CRWQCB, Lahontan Region
(760) 241-7365
kdunn@waterboards.ca.gov

Glossary

Administrative Record – A collection of all documents relied upon to select an alternative for remedial action.

Applicable or Relevant and Appropriate Requirements (ARARs) – Promulgated and enforced federal and state regulations pertaining to the cleanup of a contaminated site (e.g. cleanup standards, required site controls, etc.)

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – Also known as Superfund, this act established regulations pertaining to closed and abandoned hazardous waste sites.

DNAPL – Dense non-aqueous phase liquids, or contaminants in a relatively pure phase that are heavier than water. At South AFRL, the DNAPLs are the chlorinated solvents trichloroethene (TCE) and tetrachloroethene (PCE).

Feasibility Study – A document, prepared for regulatory review, which details the development, screening, and evaluation of alternatives for cleanup of a contaminated site.

Fractured granitic bedrock – Geological formation made up of crystalline igneous rock known as granite with small fractures, or cracks, through which liquids can move.

Geographic information system – A computer system used for the storage and organization of spatially-referenced information.

Groundwater – Underground water that fills pores in soils or openings in rocks to the point of saturation. Groundwater is often used as a source of drinking water via municipal or domestic wells.

Land Use Controls – Engineering or administrative controls to prevent the public from contact with site contaminants.

Monitoring – Collection of information about the environment that helps gauge the effectiveness of a cleanup action. At the South AFRL, groundwater wells are used to monitor plume movement and characteristics.

National Contingency Plan (NCP) – This federal plan, which applies the CERCLA law, was created to establish a cohesive government response to both oil spills and hazardous substance releases.

Plume – An area of contaminated groundwater.

Preliminary Remediation Goals (PRGs) – Risk-based concentrations of chemicals published by the U.S. EPA Region IX, for evaluating contaminated sites.

Principal threat wastes – Source materials that are considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to people or wildlife should exposure occur.

Proposed Plan – A document, specifically prepared for public review and comment, that summarizes the feasible remedial alternatives and the preferred alternative identified in a Plan of Action or Feasibility Study.

Remedial Investigation – A sampling program including the collection of soil, air, and groundwater samples to determine the types and amounts of contaminants present and the area the contaminants cover. Risk assessments are performed during the Remedial Investigation to determine potential health threats to people and wildlife due to exposure to contaminated soil, air, and groundwater.

Safe Drinking Water Act maximum contaminant level (MCL) – The maximum permissible level of a contaminant in water that is delivered to any user of a public water system.

Source materials – Materials that contain hazardous substances, pollutants, or contaminants that act as the starting point of contaminant migration to groundwater and may be highly toxic and not readily contained. Although the majority of the contaminants dissolve and mix with groundwater, some contaminants do not dissolve. This undissolved concentration of the contaminant acts as a continuing source of contamination, such as occurs at Sites 37 and 133 in the South AFRL.

Technical Impracticability (TI) Waiver – Concurrence between the lead agency (in this case, the Air Force) and the U.S. EPA that the concentrations of specific contaminants will be allowed to exceed specific ARARs within a defined area, due to the inability of current technology to feasibly treat the contamination.

Threshold Criteria – Required components identified by the US EPA, against which remedial alternatives are weighed; specifically, the overall protection of human health and the environment and compliance with ARARs.

We welcome your comments on the Edwards Air Force Base South Air Force Research Laboratory Proposed Plan

Public input regarding the Proposed Plan for Edwards Air Force Base South AFRL is important to the Air Force. Comments provided by the public are valuable in helping the Air Force select a final cleanup remedy for the South AFRL. If you have any questions about the comment period, please contact Gary Hatch of Environmental Public Affairs @ (661) 277-1454.

Comments may also be submitted to the Air Force via email at: Gary.Hatch@edwards.af.mil. Hard copy comments may be mailed to: 95 ABW/PAE, 5 East Popson Avenue, Building 2650A, Edwards AFB, California, 93524-8060, Attention: Gary Hatch. You may add additional pages to this form, as necessary. When you are finished, you can give your form to our staff or mail it.

Comments must be postmarked by 8 May 2006.

Name ______________________________ Home Phone __________________

Address ______________________________ Work Phone __________________

City ______________________________ State _________ Zip ______________

Comment or concern:

If you'd like to speak directly with someone about your concern, please contact Gary Hatch, Chief of Environmental Public Affairs, at (661) 277-1454.